Enhancement of SNR for Radars

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--**ABSTRACT**---
RADAR (RAdio Detection and Ranging) use modulated waveforms and directive antennas to transmit electromagnetic energy into a specific volume in space to search for targets. The targets within the volume reflect echoes back to the radar which are further processed to extract target information. A better SNR (Signal to Noise Ratio) to for radar surveillance is achieved. The results are provided by Matlab simulation.
Key Words: *SNR (Signal to noise ratio).*

I.   Introduction

Radars are classified as ground based, airborne, space-borne or ship based radar systems. They are also classified based on the characteristics such as frequency band, antenna type, waveform utilized. Furthermore classification is based on functionality of the radar []. A ground based radar has a transmitting antenna and a receiving antenna. The transmitting antenna transmits a modulated signal towards the target and the target reflects back the signals. These reflected signals are then processed by the receiver antenna and the targets are detected. The extraction of the target information is done by the signal processing block [6]. First task is surveillance (search) of the target. This is done by continuously scanning a specified volume in space to search for the targets of interest and second task is accomplished of detection. Once detected the target information is extracted. Space borne radars are also one of the area for detection and imaging of targets where usually SAR (Synthetic Aperture Radars) are used. Where moving target localization has proven challenging in the case of single antenna conventional narrow-angle SAR utilizing conventional reconstruction methods such as the polar format and filtered-back-projection algorithms [2-3] due to an inherent ambiguity in target geo-location and velocity. The techniques for imaging moving targets with conventional SAR aim at focusing and detecting smeared targets in SAR imagery [2-6]. A number of techniques to handle moving objects explicitly have been developed. Space-time adaptive processing (STAP) [7] exploits multiple-phase center antennas to suppress clutter and produce a moving target indication image. But here we will be simulating a ground based radar to search and detect the targets.

II. Model Definition:

The Peak power density P_D is the peak transmitted power per unit area at any point in space.

$$P_D = \frac{peak\ power\ transmitted}{area\ of\ a\ sphere}$$

$$P_D = \frac{P_t}{4\pi R^2} \qquad 2.1$$

R- Radius of the sphere.
For our case R denotes the range of the radar.
The directive antennas are categorized by the antenna gain and the effective aperture.

$$G = \frac{4\pi A_e}{\lambda^2} \qquad 2.2$$

Where,
λ −Wavelength.
A_e- Effective Aperture.
G – Gain of the antenna.
The power density is related to the gain of the directive antenna by

$$P_D = \frac{P_t G}{4\pi R^2} \qquad 2.3$$

The radar radiated energy impinges on a target and the target reflects back the energy in all directions. This radiated energy is proportional to the radar cross section. The radar cross section is given as

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$$\sigma = \frac{P_r}{P_D} \qquad 2.4$$

Where,

P_r – Power reflected from the target.

So, the total power delivered to radar signal processor by the antenna is,

$$P_{Dr} = \frac{P_t G \sigma}{(4\pi R^2)^2} A_e \qquad 2.5$$

Further,

$$P_{Dr} = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 R^4} \qquad 2.6$$

If S_{min} is the detectable signal power then the maximum radar range is given by,

$$R_{max} = \left(\frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 S_{min}} \right)^{\frac{1}{4}} \qquad 2.7$$

The Noise Figure F is,

$$F = \frac{(SNR)_i}{(SNR)_o} \qquad 2.8$$

$(SNR)_i \text{ and } (SNR)_o$ Are, Signal to Noise Ratios of input and output of the receiver.

The minimum output SNR is set equal to the radar detection threshold.

$$(SNR)_o = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 k T_e B F R_{max}^4} \qquad 2.9$$

Now, considering the parameters for the design.

Table 2.1. Parameters and their respective quantities.

Parameter	Quantity
Peak power	4.5Mwatts
Operating Frequency	4GHz
Antenna Gain	35.0 dB
Radar cross section	0.3 square meters
Effective temperature	290.0 kelvin
Bandwidth	9MHz
Noise figure	3.0dB
Loss	4.0 dB

III. Simulation Results:

Figure3.1. SNR values vs detection range for the different radar cross section values.
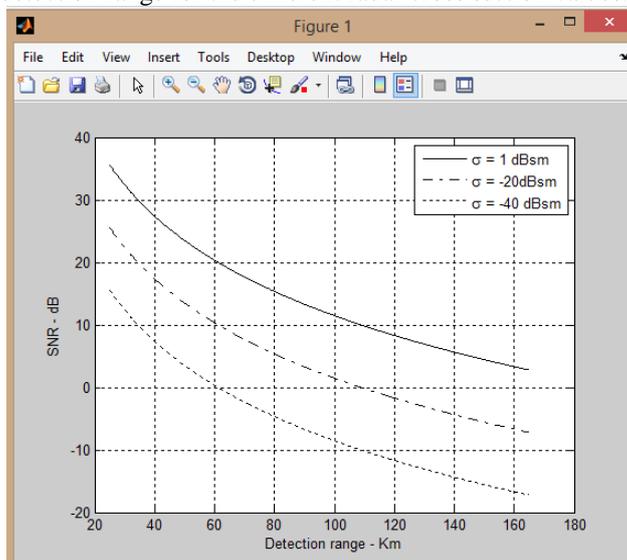

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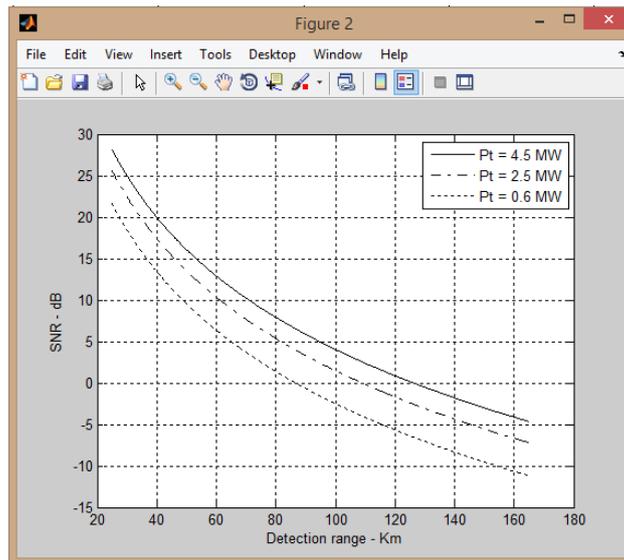
Figure3.2. SNR values vs detection range for the various transmitted power.

The Figure3.1 and Figure 3.2 show the SNR and detection range values for different values of the radar cross section and power transmitted by the radar.As the radar cross section increases from -40 dBsm to 1 dBsm the SNR values change from 15dB to 35 dB which is a considerable difference. The increase in the transmitted power increases the SNR from 22dB to 28dB with varying detection ranges

IV. Conclusion:

So with the above results we have much better SNR with the increase in the radar cross section and the transmitted power. Hence the power transmitted and the radar cross section play a key role in increasing the SNR of a radar.

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Key-Words: - Generalized detector, additive Gaussian noise, detection performance, constant false alarm rate (CFAR), generalized approach to signal processing (GASP), high resolution radar, signal-to-noise ratio (SNR). 1 Introduction. High-resolution radar (HRR) can resolve a target in-to a number of scattering centers, depending on the range extent of the target and the range resolution capabilities of the radar. In particular, radar detection of distributed targets in white Gaussian noise of known spectral density le-vel has been addressed in [4]. Therein, two detection structures have been proposed, and the results indi-cate that properly designed HRRs allow significant enhancement of the detection performance. The possible improvement depends upon two fa-ctors, namely Signal-to-noise ratio (SNR or S/N) is a measure used in science and engineering that compares the level of a desired signal to the level of background noise. SNR is defined as the ratio of signal power to the noise power, often expressed in decibels. A ratio higher than 1:1 (greater than 0 dB) indicates more signal than noise. SNR, bandwidth, and channel capacity of a communication channel are connected by the Shannon–Hartley theorem. SNR Enhancement of Back Scattering Signals for Bistatic Radar Based on BeiDou GEO Satellites. by. Yan Li. 1. Introduction. Using global navigation satellite system (GNSS) reflected signals to construct a bistatic radar for remote sensing on an object is a popular issue. When the radio signal transmitted from the navigation satellite impinges on the target, it is reflected and contains the target information, then a satellite-based, aircraft-based, or ground-based receiver is employed to capture this signal and retrieve the physical parameters such as vegetation optical depth, soil moisture, sea ice surface, and ocean surface wind speed [1,2]. Especially, when the receiver. Besides this enhancement in SNR, it has a drawback due to sidelobe levels which degrade the filter response. There are many additional techniques which reduce these levels such as window techniques and inverse filter. In this paper, a new approach is utilized to completely cancel the level of matched filter side lobes based on the signal recovery of the compressive sensing (CS) theory. The recovered chirp radar signals are achieved with completely side lobes cancellation compared to the traditional side lobe reduction technique based on the widow method. The comparison between the proposed and traditional methods is achieved according to the detection performance using Receiver Operating Characteristic (ROC) curve.